Realistic scaling of plant root systems for centrifuge modelling of root-reinforced slopes

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SESSION 2 – SLOPE STABILITY MODELLING

SBEE34 – Realistic scaling of plant root systems for centrifuge modelling of root-reinforced slopes

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Vegetation as a means to improve slope stability is well recognised and incorporated in geotechnical and ecological engineering practice to protect slopes against shallow landslides. Much of the research in this area has quantified root reinforcement of soil shear behaviour at prescribed soil depths in either the laboratory or the field. Costs and practicality limit testing of global behaviour, where full-scale field trials can be brought to failure to determine plant root impacts on the depth of failure and critical hydrological conditions. Geotechnical centrifuge modelling offers an opportunity to investigate in detail the engineering performance of vegetated slopes, but its application has been restricted due to the challenge of scaling plant root systems. Some work has relied on scaled model roots, provided by either live plants or analogue material with similar mechanical properties (stiffness and strength) and a realistic 3-D geometry at small scale.

For root analogues, a 3-D printing technique has recently been introduced by the authors, to reproduce representative root morphologies with appropriate mechanical properties (Liang et al., 2015). This 3-D printing technique has been used in centrifuge tests of sandy slopes subject to earthquake loadings, and showed substantial benefits of analogue root reinforcement.

In previous studies using live plants (e.g. Sonnenberg et al., 2010), model scaling effects have not been considered in detail. This may have contributed to over-prediction of root reinforcement and relatively poor prediction of slope response. We are performing studies to identify candidate species to better represent scaled root morphologies and mechanical characteristics for use in centrifuge modelling. Three species (willow, gorse and grass), corresponding to distinct plant groups were selected and cultivated for approximately two months following preliminary assessment of suitable species. Root morphologies, tensile strengths and Young's modulus of these juvenile root samples were then measured and compared with results from more mature field grown specimens. Results from these tests will be discussed in relation to the use of juvenile plant root systems and root system analogues in scaled centrifuge testing.

Reference

Liang, T., Knappett, J.A., Duckett, N., 2015. Modelling the seismic performance of rooted slopes from individual root – soil interaction to global slope behaviour. Géotechnique **65(12)**, 995–1009.

Sonnenberg, R., Bransby, M.F., Hallett, P.D., et.al. 2010. Centrifuge modelling of soil slopes reinforced with vegetation. Can. Geotech. J. **47(12)**, 1415–1430.

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